AbstractID: 3006 Title: 3D respiratory motion estimation from slowly rotating 2D-Xray projection views

Purpose: To more directly model changes in patient configuration due to respiratory motion during gantry rotation for "4D" cone-beam CT (CBCT).

Method and Materials: The process takes advantage of the similarity between the patient at treatment and their model from a prior (planning) CT scan. A reference thorax volume is obtained from a conventional fast CT scanner under breath-hold conditions. At treatment, a sequence of projection views of the same patient is acquired using a slowly rotating cone-beam system, which takes 1 minute for a full rotation. Breathing motion over the entire acquisition period is estimated by deforming the reference volume through time to best match the measured projection views. A B-spline based motion model is used to describe free breathing motion. Optimized parameters of this model (by minimizing a regularized square error cost function) determine the motion of each point of the object at any time within the scanning period. Performance of this approach was evaluated by simulation, in which a 128x128x40 reference thorax volume and a 3D cone-beam geometry were used to generate 12 projection views of one breathing cycle.

Results: Results showed good agreement between the estimated and true motion. A 30-degree angular rotation during one breathing cycle (5 seconds) yielded a mean absolute estimation error (MAE) of 0.7 mm (maximum 2.1mm). A 360-degree angular rotation yielded MAE of 0.4mm (maximum 1.3mm).

Conclusions: It is feasible to estimate non-rigid motion from a sequence of slowly rotating projections. Improved accuracy with increased angular range indicates advantages of faster rotation or limited periodicity constraints.

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